LM5020 Reference Design - Dual Output Flyback Converter with isolated outputs of 5V@0.2A and 12V@2.1A. Two LM2736Y's provide an additional output of 3.3V@0.5A and 5V@0.5A.

National Semiconductor
LM5020
Power Applications Design Center, Americas
May 2007

1.0 Design Specifications

Inputs	Output #1	Output #2	Output #3	Output #4
VinMin=9V	Vout1=5V	Vout2=12V	Vout3=3.3V	Vout4=5V
VinMax=42V	Iout1=0.2A	Iout2=2.1A	Iout3=0.5A	Iout4=0.5A

2.0 Design Description

This design utilizes the LM5020 Current Mode PWM Controller configured in a dual output Flyback converter. This isolated design operates at 300kHz and uses a custom transformer to convert the input voltage, via flyback action, to an output voltage level of 12V at 2.1A, as well as produce an isolated 5V@0.2A rail. The relative low output power of this design, and the fact that V_{cc} is not required to power additional IC's, allows the primary bias winding to be connected to V_{in}. The LM5020 has a minimum input voltage of 13V so a start-up bias circuit was added to apply an external voltage to V_{cc} until the input voltage reached the proper threshold level.

With total potential output power less than 30W, a custom EFD20 core was chosen for this design. Because of the input voltage range, a CCM to DCM transition tradeoff was made to minimize losses associated with DCM operation. Radiated EMI requirements necessitated the use of snubbers and other filtering elements to minimize high energy signals from interfering with adjacent circuitry.

The 12V rail also fed a 5V@0.5A rail, as well as an optional 3.3V@0.5A rail. The secondary side feedback components are selected appropriately to ensure the voltage regulation remains solid and that proper gain and phase margins are maintained for stable operation and quick transient response.

LM5020 Reference Design - Dual Output Flyback Converter with isolated outputs of 5V@0.2A and 12V@2.1A. Two LM2736Y's provide an additional output of 3.3V@0.5A and 5V@0.5A.LM5020

3.0 Schematic

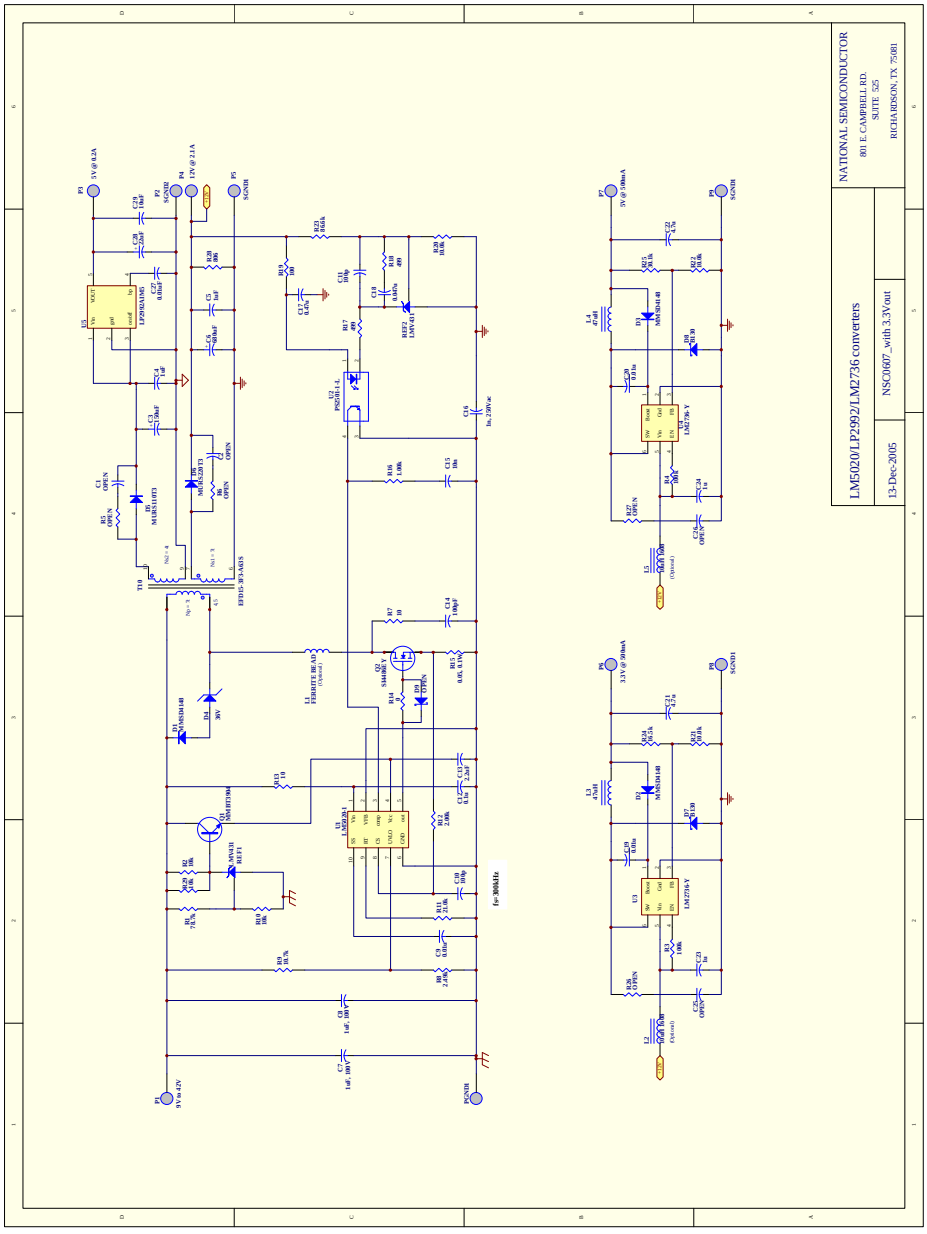


FIGURE 1. Schematic

4.0 Bill of Materials

NSC0607 LM5020/LP2992/LM2736 - Vin=9-42V,
Flyback Converter: Vout =5V(I)@0.2A, 12V@2.1A w/ 5V@0.5A; and optional 3.3V@0.5A Buck Converter 12-13-2005

Designator	Part Type	Footprint	Description	Manufacturer
C1	OPEN			
C10	100pF	805	Capacitor Ceramic X7R	Vitramon/VJ0805
C11	100pF	805	Capacitor Ceramic X7R	Vitramon/VJ0805
C12	0.1uF	805	Capacitor Ceramic X7R	Vitramon/VJ0805
C13	2.2uF	805	Capacitor Ceramic X7R	Vitramon/VJ0805
C14	100pF	805	Capacitor Ceramic X7R	Vitramon/VJ0805
C15	10nF	805	Capacitor Ceramic X7R	Vitramon/VJ0805
C16	1nF, 250Vac	1808	Capacitor Ceramic X7R	Syfer/1808JA250102KXBSY2
C17	0.47uF	805	Capacitor Ceramic X7R	Vitramon/VJ0805
C18	0.047uF	805	Capacitor Ceramic X7R	Vitramon/VJ0805
C2	OPEN			
C20	0.01uF	805	Capacitor Ceramic X7R	Vitramon/VJ0805
C22	4.7uF	805	Capacitor Ceramic X7R	Vitramon/VJ0805
C24	1uF	805	Capacitor Ceramic X7R	Vitramon/VJ0805
C26	OPEN			
C27	0.01uF	805	Capacitor Ceramic X7R	Vitramon/VJ0805
C28	22uF	Sanyo CV-FS	Capacitor Electrolytic	Sanyo/6CV22FS
C29	10uF	1210	Capacitor Ceramic X7R	TDK/C3225X7R1C106
C3	150uF	SANYO MV-WX	Capacitor Electrolytic	Sanyo/6MV150WX
C4	1uF	805	Capacitor Ceramic X7R	Vitramon/VJ0805
C5	1uF	805	Capacitor Ceramic X7R	Vitramon/VJ0805
C6	680uF	SANYO MV-WG	Capacitor Electrolytic	Sanyo/16MV680WG
C7	1uF, 100V	1210	Capacitor Ceramic X7R	TDK/C3225X7R2A105
C8	1uF, 100V	1210	Capacitor Ceramic X7R	TDK/C3225X7R2A105
C9	0.01uF	805	Capacitor Ceramic X7R	Vitramon/VJ0805
D1	MMSD4148	SOD-123	Small Signal Diode	Vishay/MMSD4148
D3	MMSD4148	SOD-123	Small Signal Diode	Vishay/MMSD4148
D4	SMAJ_36V	SMA	Transient Suppressor Diode	Diodes/SMAJ36
D5	MURS110T3	SMB	Surface mount schottky diode	OnSemi/MURS110
D6	MURS220T3	SMB	Surface mount schottky diode	OnSemi/MURS220
D8	B130	SMA	Surface mount schottky diode	Diodes/B130-13
D9	OPEN			
L1	FERRITE BEAD	Bead Core	Ferrite Bead Core	Panasonic/EXC-ML45A910H
L4	47uH	DO3316	Surface Mount Power Inductor	Coilcraft/DO3316P-473ML
L5	10uH	1812PS	Surface Mount Power Inductor	Coilcraft/1812PS-103KL
Q1	MMBT3904	SOT23	N-NPN Bipolar Transistor	Fairchild/MMBT3904
Q2	SI4486EY	SO-8	N-Channel Power MOSFET	Vishay/SI4486EY
R1	78.7k	805	1% Thick Film	DALE CRCW0805
R10	10k	805	1% Thick Film	DALE CRCW0805
R11	21.0k	805	1% Thick Film	DALE CRCW0805
R12	2.00k	805	1% Thick Film	DALE CRCW0805
R13	10	805	1% Thick Film	DALE CRCW0805
R14	0	805	1% Thick Film	DALE CRCW0805
R15	0.05, 0.1W	0805	1% Thick Film	DALE CRCW0805
R16	1.00k	805	1% Thick Film	DALE CRCW0805
R17	499	805	1% Thick Film	DALE CRCW0805
R18	499	805	1% Thick Film	DALE CRCW0805
R19	100	805	1% Thick Film	DALE CRCW0805
R2	10k	805	1% Thick Film	DALE CRCW0805
R20	10.0k	805	1% Thick Film	DALE CRCW0805
R22	10.0k	805	1% Thick Film	DALE CRCW0805
R23	86.6k	805	1% Thick Film	DALE CRCW0805
R25	30.1k	805	1% Thick Film	DALE CRCW0805
R27	OPEN	805		

bom2

FIGURE 2. Bill of materials, page 1

NSC0607 LM5020/LP2992/LM2736 - Vin=9-42V,
Flyback Converter: Vout =5V(I)@0.2A, 12V@2.1A w/ 5V@0.5A; and optional 3.3V@0.5A Buck Converter 12-13-2005

Designator	Part Type	Footprint	Description	Manufacturer
R28	806	1206	1% Thick Film	DALE CRCW1206
R29	10k	805	1% Thick Film	DALE CRCW0805
R4	100k	805	1% Thick Film	DALE CRCW0805
R5	OPEN	805		
R6	OPEN	805		
R7	10	805	1% Thick Film	DALE CRCW0805
R8	2.49k	805	1% Thick Film	DALE CRCW0805
R9	10.7k	805	1% Thick Film	DALE CRCW0805
REF1	LMV431	SOT25	Low voltage precision shunt regulator	National/LMV431
REF2	LMV431	SOT25	Low voltage precision shunt regulator	National/LMV431
T10	EFD15-3F3-A63S	EFD15	Power Transformer	Coilcraft Custom/EFD15
U1	LM5020-1	MSOP-10	100V Current Mode PWM Controller	National/LM5020
U2	PS2501-1-L	PS2501	Surface Mount Opto-coupler	NEC/PS2501L-1-H
U4	LM2736-Y	SOT23-6	Step-Down DC-DC Regulator	National/LM2736
U5	LP2992AIM5	SOT23-5	Micropower Low Noise LDO	National/LP2992AIM5

BOM Total Considering Additional 3.3V Output

C19	0.01uF	805	Capacitor Ceramic X7R	Vitramon/VJ0805
C21	4.7uF	805	Capacitor Ceramic X7R	Vitramon/VJ0805
C23	1uF	805	Capacitor Ceramic X7R	Vitramon/VJ0805
C25	OPEN	805		
R21	10.0k	805	1% Thick Film	DALE CRCW0805
R24	16.5k	805	1% Thick Film	DALE CRCW0805
R26	OPEN	805		
R3	100k	805	1% Thick Film	DALE CRCW0805
D2	MMSD4148	SOD-123	Small Signal Diode	Vishay/MMSD4148
D7	B130	SMA	Surface mount schottky diode	Diodes/B130-13
L3	47uH	DO3316	Surface Mount Power Inductor	Coilcraft/DO3316P-473ML
L2	10uH	1812PS	Surface Mount Power Inductor	Coilcraft/1812PS-103KL
U3	LM2736-Y	SOT23-6	Step-Down DC-DC Regulator	National/LM2736

bom3

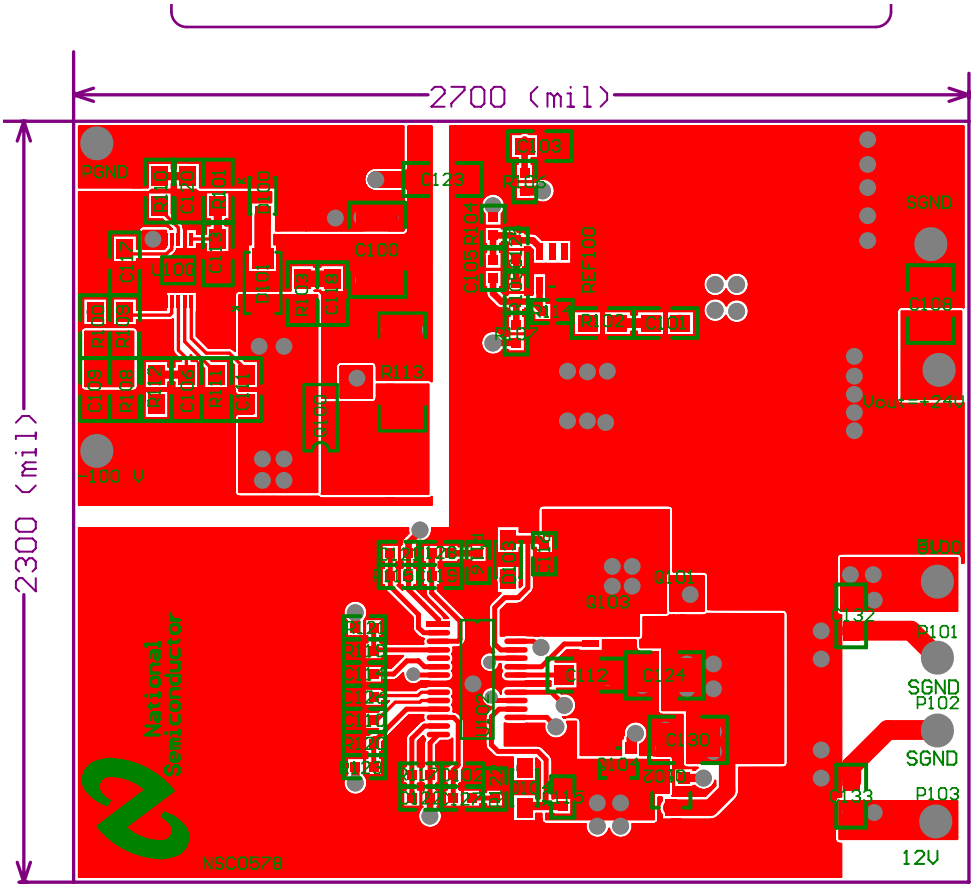
FIGURE 3. Bill of materials, page 2

5.0 Other Operating Values

Operating Values

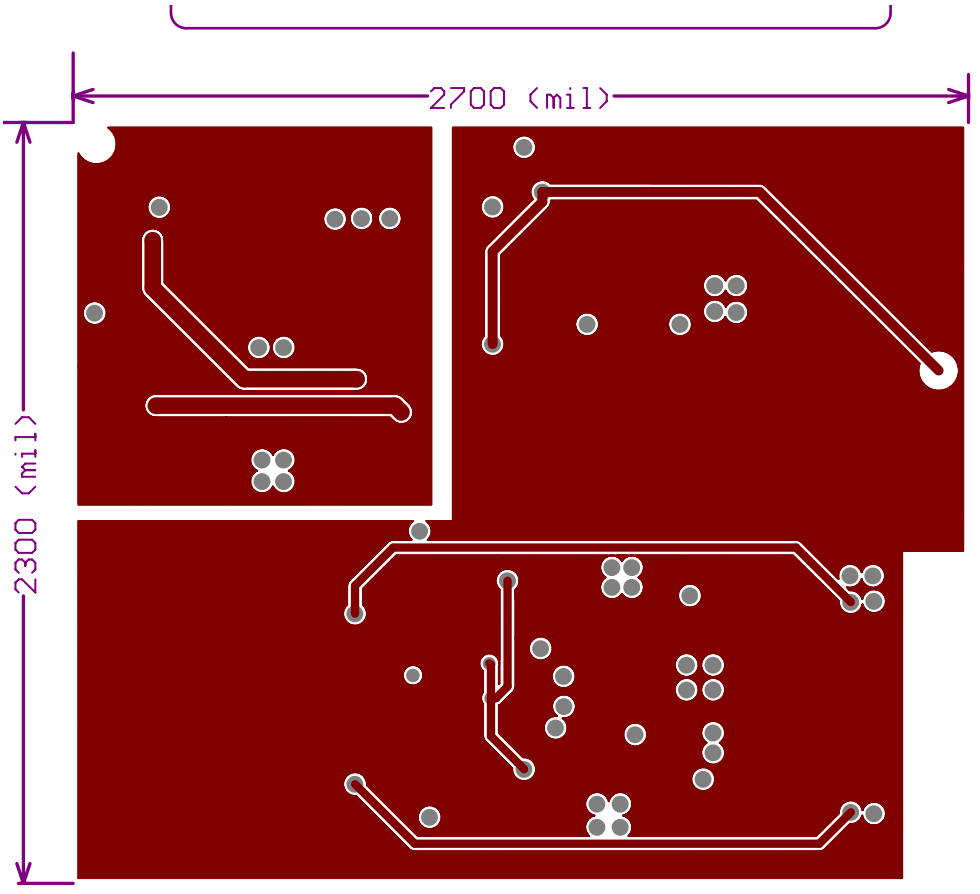
Description	Parameter	Value	Unit
Modulation Frequency	Frequency	300	KHz
Total output power	Pout	30	W
Peak to peak ripple voltage, 9Vin with full load	Vout p-p	250	mV
Peak to peak ripple voltage, 42Vin with full load	Vout p-p	200	mV
Dynamic Load Regulation, Vin = 9V, half load on 3.3V, 5V, Outputs, full load step	Dynamic Load	400	mV
Dynamic Load Regulation, Vin = 42V, half load on 3.3V, 5V, Outputs, full load step	Dynamic Load	300	mV

6.0 Layouts



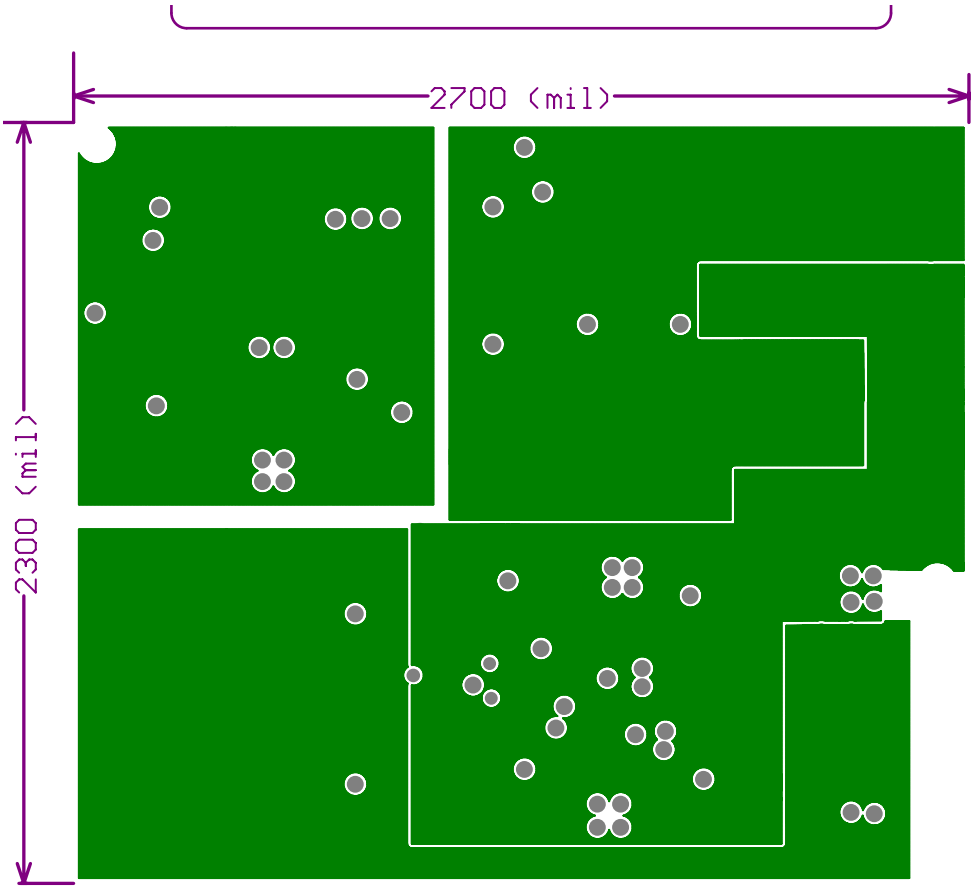
layout9

FIGURE 4. Top Layer



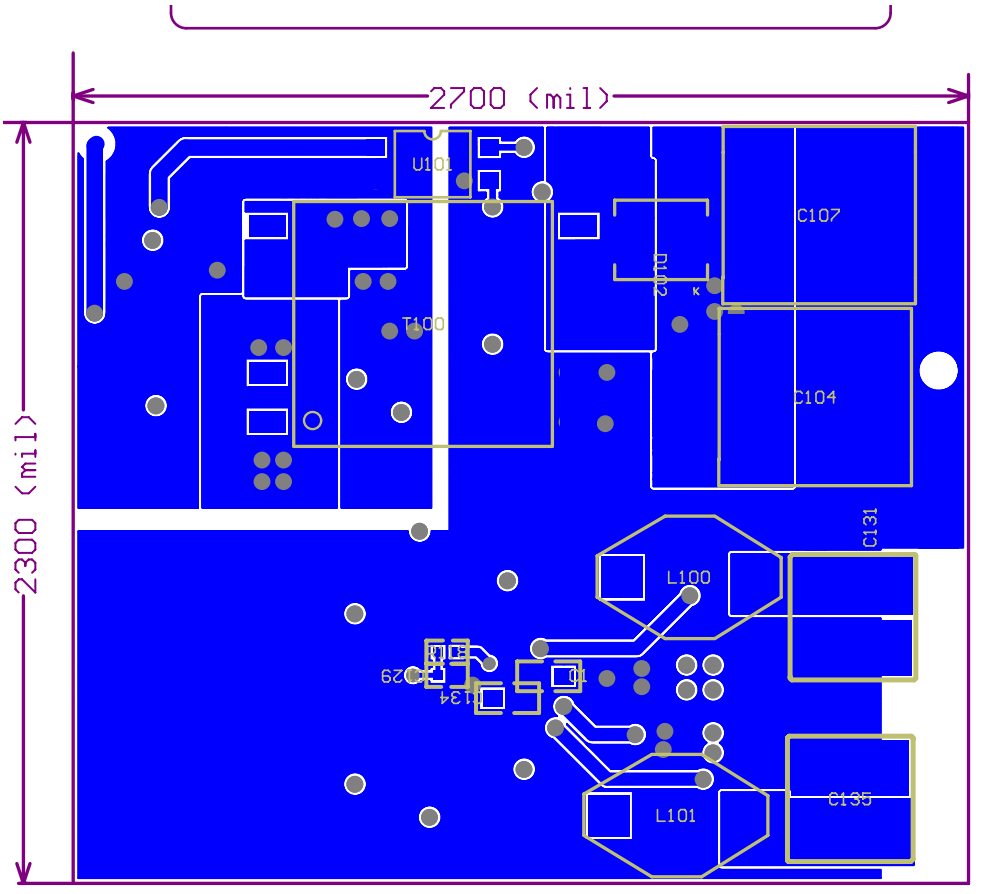
layout10

FIGURE 5. Middle Layer 1



layout11

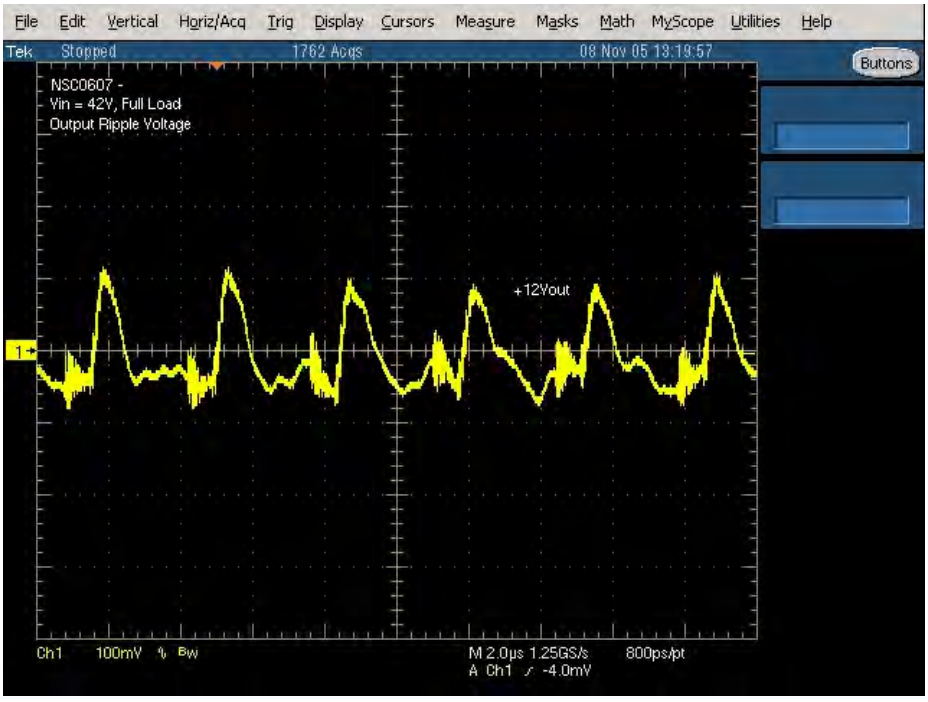
FIGURE 6. Middle Layer 2



layout12

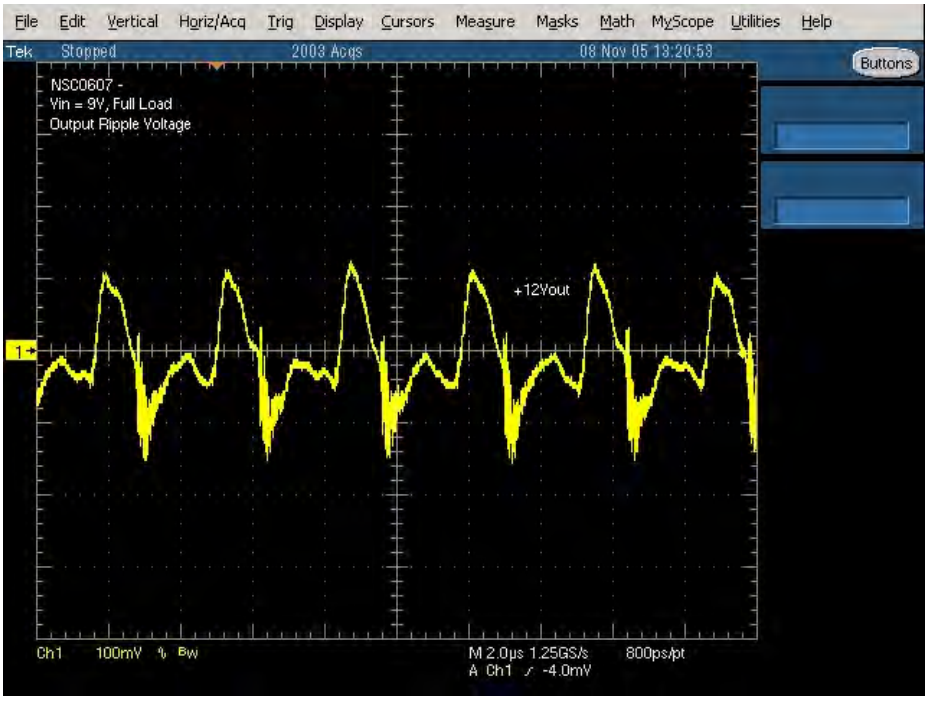
FIGURE 7. Bottom Layer

7.0 Waveforms



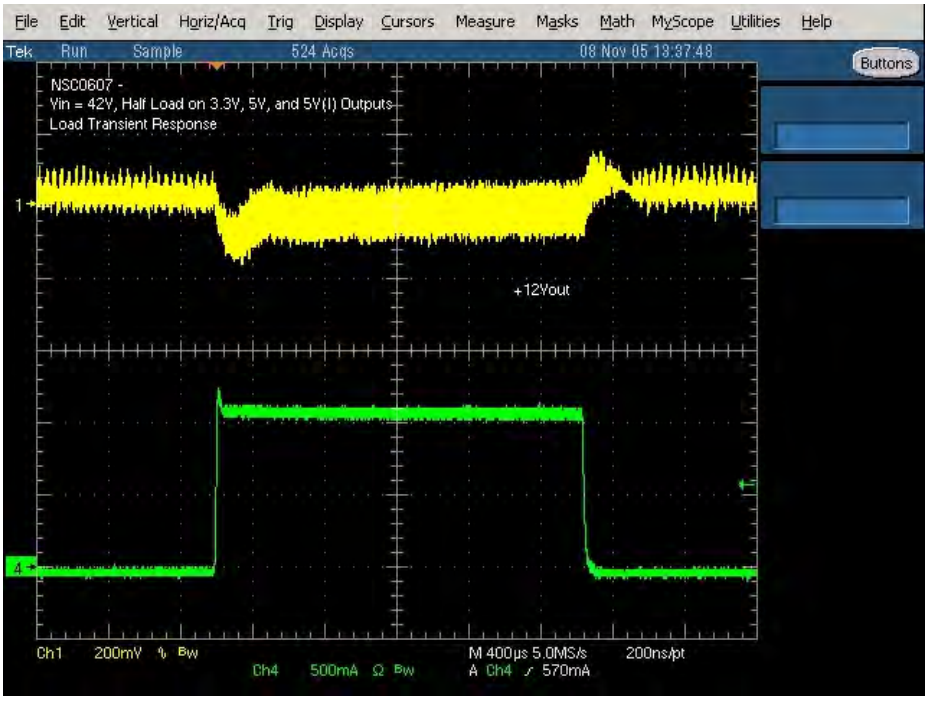
waveform4

FIGURE 8. Output Ripple, Vin=42V



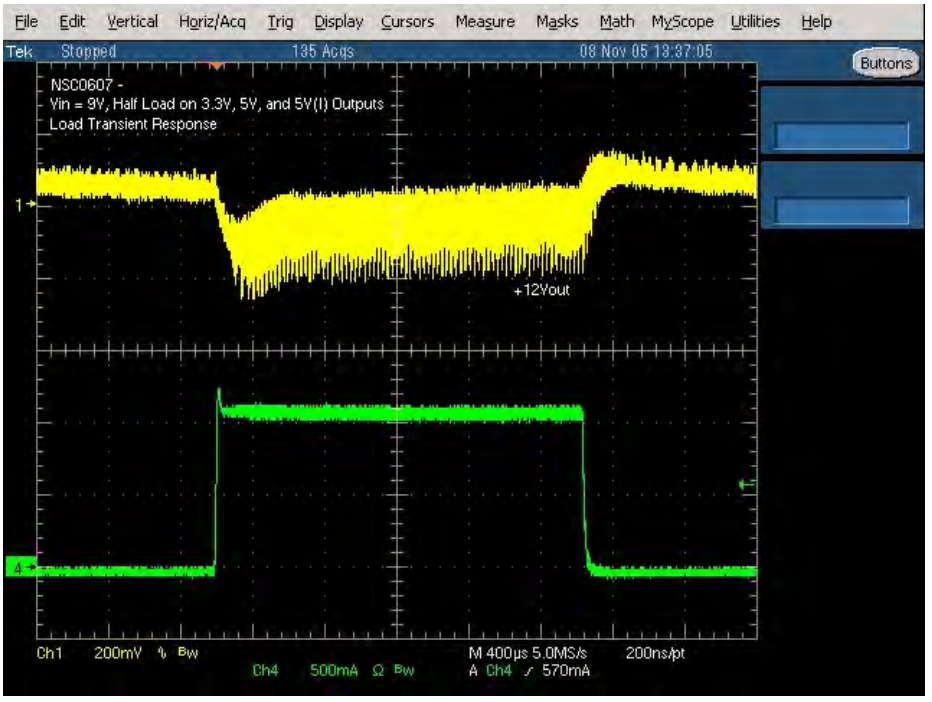
waveform5

FIGURE 9. Output Ripple, Vin=9V



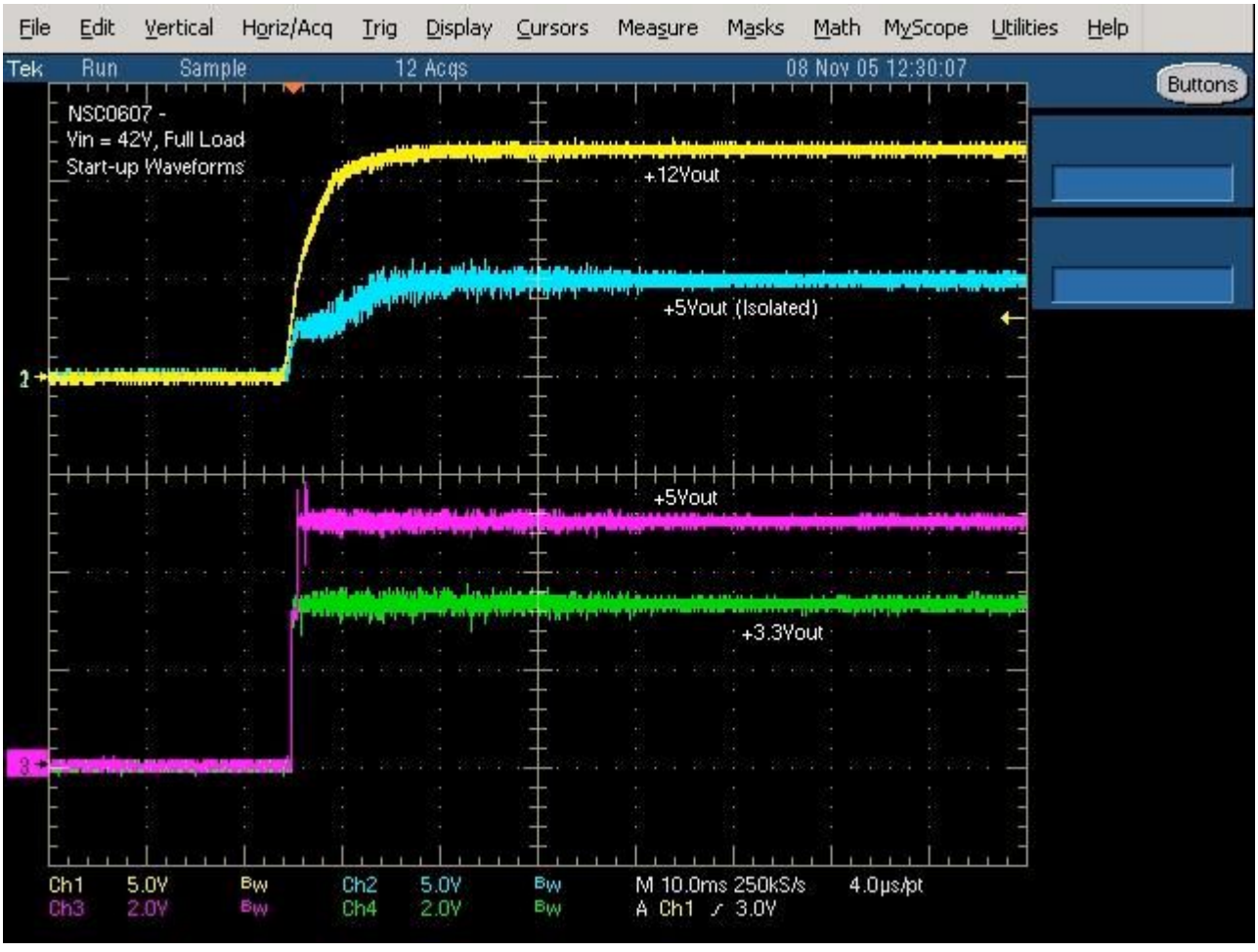
waveform6

FIGURE 10. Load Transient, Vin=42V



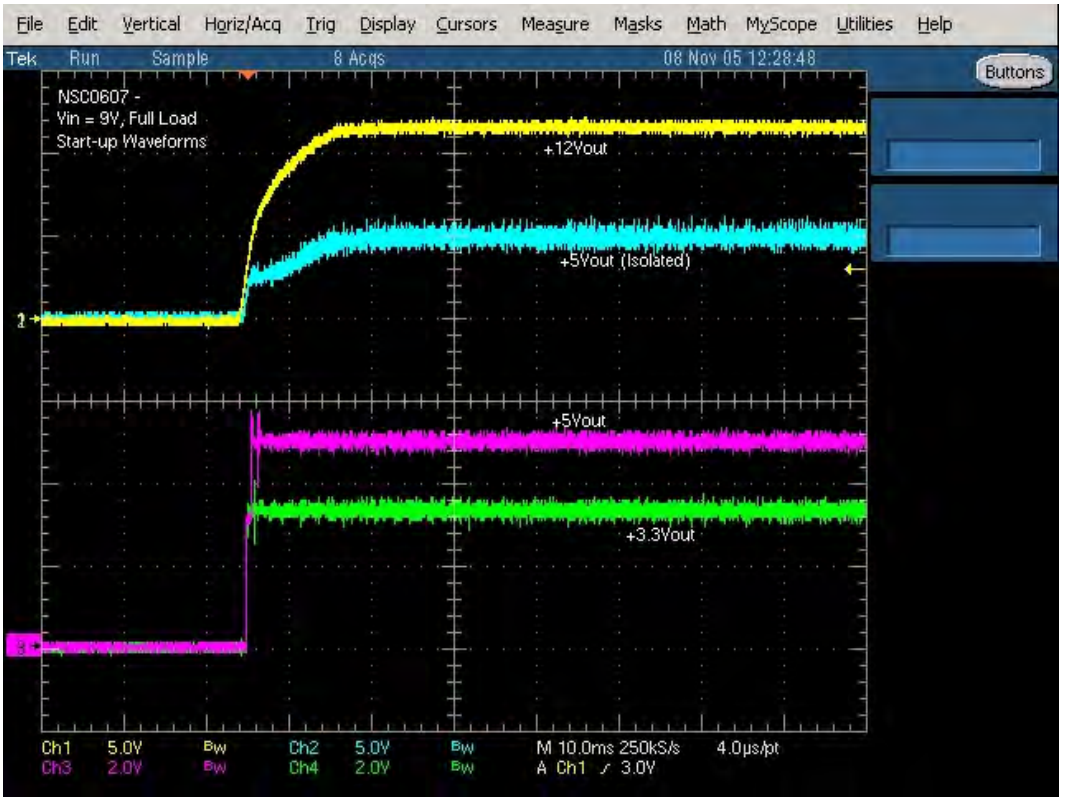
waveform7

FIGURE 11. Load Transient, Vin=9V



waveform

FIGURE 12. Start up waveforms, Vin=42V

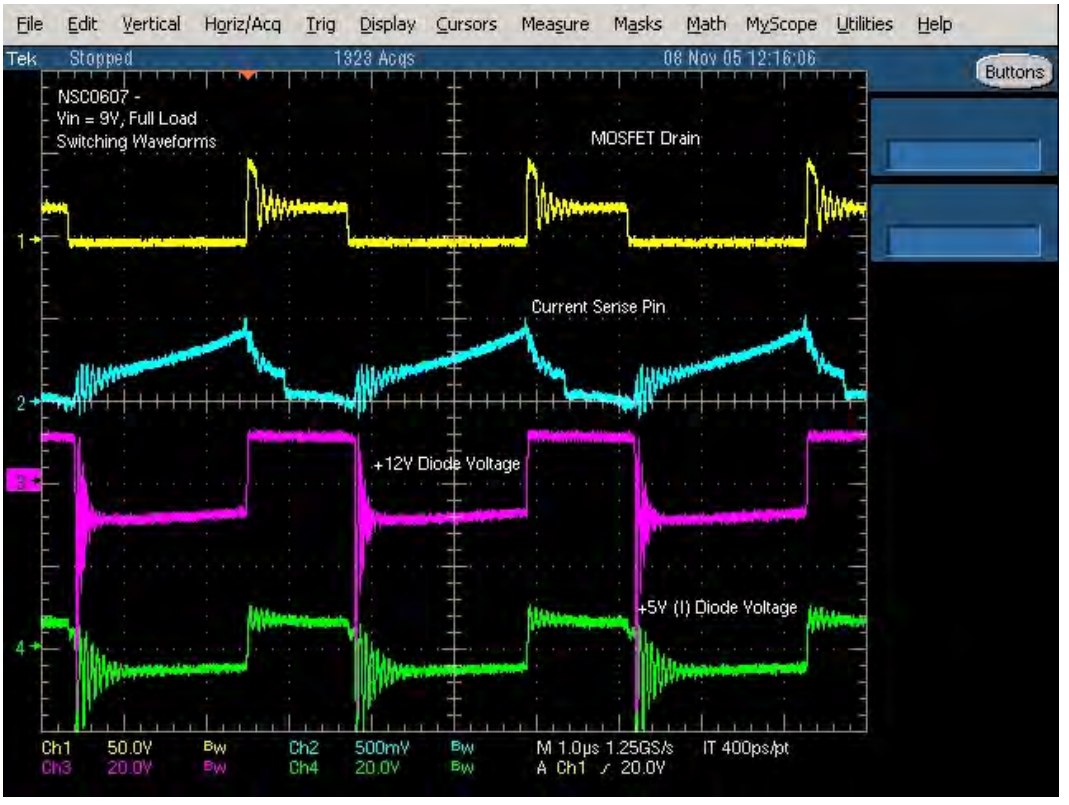


waveform8

FIGURE 13. Start up waveforms, Vin=9V

waveform9

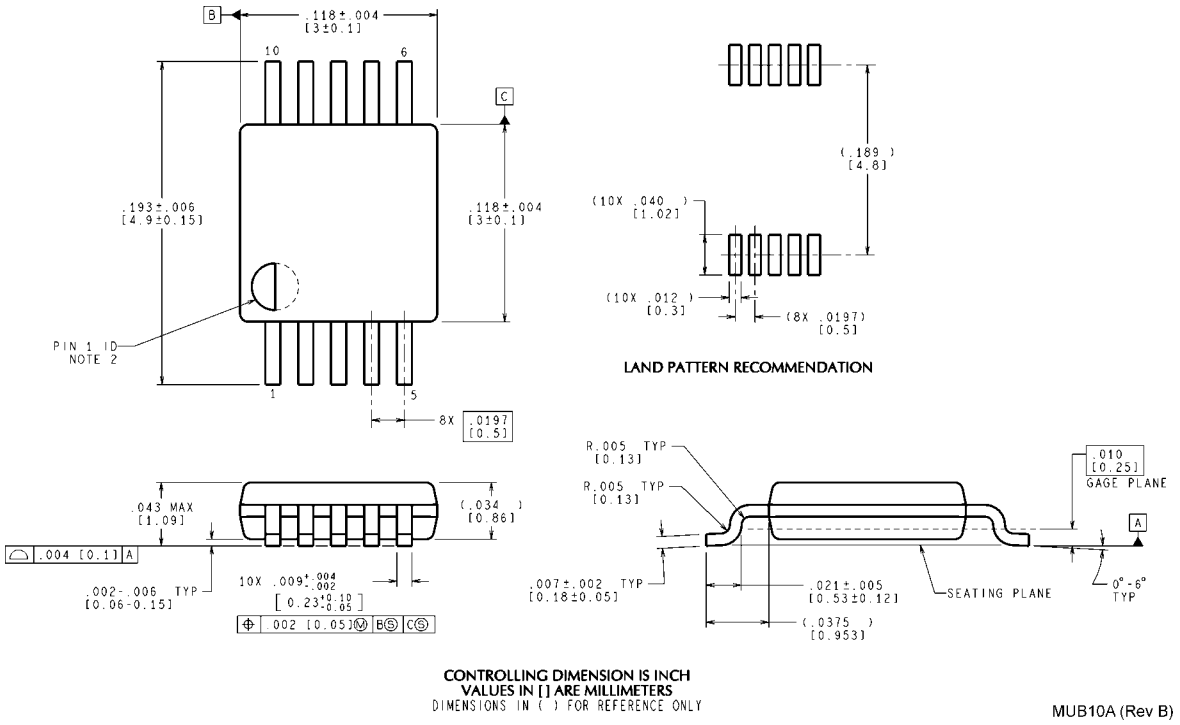
FIGURE 14. Switching waveforms, Vin=42V



waveform10

FIGURE 15. Switching waveforms, Vin=9V

8.0 Physical Dimensions inches (millimeters) unless otherwise noted



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DIMENSIONS IN ( ) FOR REFERENCE ONLY

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Notes

Notes

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